FEHM: Finite Element Heat and Mass
Modeling the subsurface

Earth & Environmental Sciences

Los Alamos NATIONAL LABORATORY — EST.1943 —
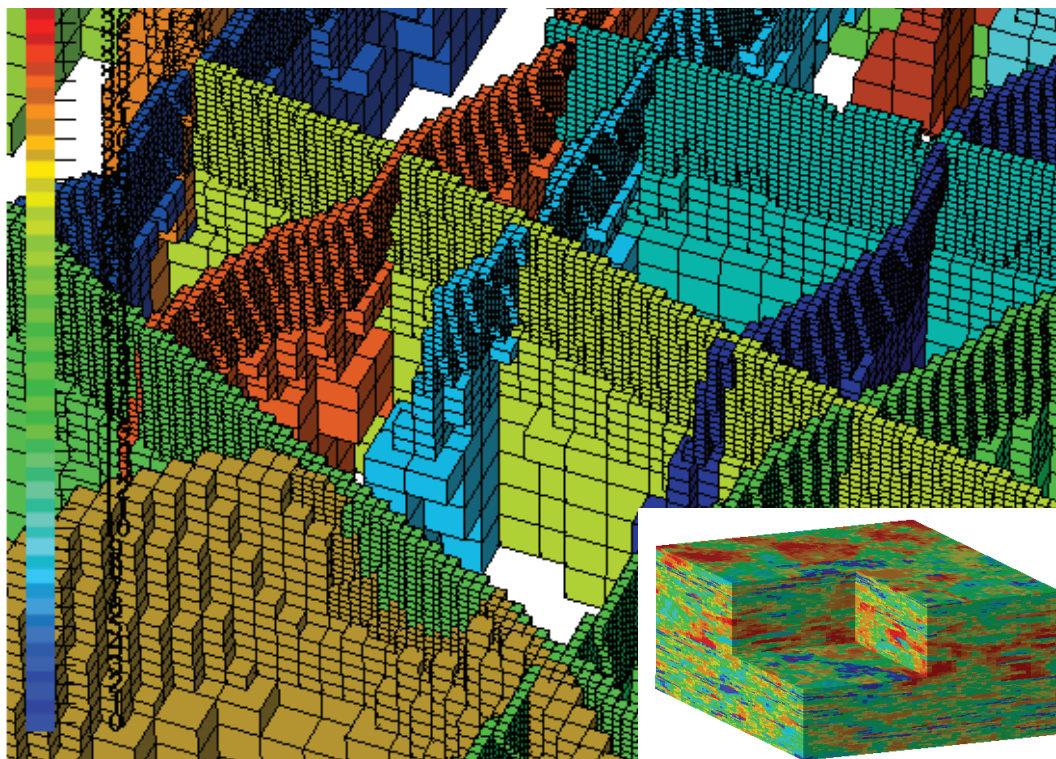
Modeling natural phenomena such as geology, hydrology, geomorphology and other environmental systems that interact at or below the earth's surface is a complex task. Los Alamos' FEHM is a sophisticated analysis tool, refined over several decades, that successfully simulates these complex processes and can be used for analyzing environmental hazards.

Left: *Modeling faults and fracture systems*
Inset: *Modeling the permeability of rocks*

Background

The Subsurface Flow and Transport Team at Los Alamos has been involved in large scale projects including performance assessment of Yucca Mountain, environmental remediation of the Nevada Test Site, the LANL Groundwater Protection Program and geologic CO_2 sequestration. For most early researchers, models were used primarily as tools for understanding subsurface processes. Subsequently, in addition to addressing purely scientific questions, models were used in technical evaluation roles. FEHM possesses unique features and capabilities that are of general interest to the subsurface flow and transport community and is well suited to the study of unconventional fuel development.

Capabilities

FEHM is a numerical simulation code for subsurface transport processes. It models 3D, time-dependent, multiphase, multicomponent, nonisothermal, reactive flow through porous and fractured media. It can accurately represent complex geologic structures and their effects on subsurface flow and transport. FEHM has been used to simulate groundwater and contaminant flow and transport in deep and shallow, fractured and non-fractured porous media throughout the US DOE complex.

Future Applications

This highly-adaptive model can be applied to new frontiers in the earth sciences. Some of those being explored at LANL include:
- *Extraction of heavy oil (oil sands and oil shale)*
- *Enhanced geothermal systems development*
- *Geologic CO_2 sequestration*
- *Remediation of contaminants*
- *Nuclear waste isolation*
- *Stability of earthen dams*
- *Environmental protection*

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Right: Numerical grid of the Española Basin, NM (right); enhanced resolution near proposed well in the Española Basin (left)